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IDENTIFYING THE FEASIBILITY OF NECESSARY DUSTBIN POINTS IN KHALISHPUR THANA IN KHULNA CITY BY USING GIS MAPPING

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ABSTRACT

Solid waste management is a critical challenge in urban areas, particularly in rapidly growing cities like Khulna, Bangladesh. This study focuses on identifying the feasibility of necessary dustbin points in Khalishpur (Wards 9, 10, and 11) using GIS mapping to enhance solid waste management systems. The objectives of this research were to investigate the current situation of dustbin points and propose an optimized system for waste collection by identifying suitable locations for new dustbin points. Data collection involved field surveys, interviews, and secondary data analysis to assess the spatial distribution of existing dustbin points, waste generation rates, and population density. Using GIS tools, spatial analysis was conducted to map current dustbin points, identify waste generation hotspots, and analyze accessibility for residents and waste collection vehicles. Existing dustbin points and their accessibility report were analyzed to select optimal locations for new dustbin points based on factors such as population density, road network connectivity, and environmental considerations.
The study revealed that the existing dustbin distribution is inadequate, leading to improper waste disposal and accumulation in certain areas. Proposed dustbin points were identified and validated through stakeholder consultations and field visits. The findings of this research provide actionable recommendations for municipal authorities to improve waste management in Khalishpur by integrating new dustbin points into the existing system. This study highlights the potential of GIS-based approaches in urban planning and waste management, offering a replicable framework for other urban areas facing similar challenges.

Key words: *Solid waste management, Municipal solid waste management, dustbin points, GIS mapping.*

INTRODUCTION

Solid Waste Management (SWM) is a critical component of urban planning and sustainability, addressing the challenges associated with the increasing volume of waste generated by rapid urbanization, industrialization, and population growth (Adeleke *et al*., 2020). SWM involves a comprehensive system that includes the collection, transportation, treatment, and disposal of waste, alongside efforts to recover resources through recycling and reuse (Hossain & Jahan, 2020). Proper waste management is essential not only to mitigate environmental degradation but also to safeguard public health and enhance urban livability (Bhuiyan & Hossain, 2017).

In developing countries like Bangladesh, the task of effective waste management is often compounded by insufficient infrastructure, lack of planning, and limited resources (Khan *et al*., 2019). This is evident in cities such as Khulna, where rapid urban growth and industrial activities have resulted in an overwhelming increase in waste generation. In many instances, existing waste management systems are ill-equipped to cope with the growing demands, leading to inefficiencies in waste collection, improper disposal practices, and environmental pollution (Rahman & Sattar, 2019). Such challenges not only threaten public health but also contribute to the deterioration of urban aesthetics, making cities less livable (Adeleke *et al*., 2020).

Khalishpur, a prominent area within Khulna, provides a compelling case study to address these issues. The area, which hosts both residential and industrial zones, is experiencing a rising waste generation rate, which necessitates urgent intervention in waste management practices (Khan *et al*., 2019). This study aims to explore the application of Geographic Information System (GIS) technology as a tool for optimizing waste management systems in Khalishpur. GIS, with its ability to analyze and visualize spatial data, offers a promising approach to identifying optimal dustbin placement locations, streamlining waste collection, and minimizing environmental and health risks (Liu & Zhao, 2015). By analyzing factors such as population density, waste generation, and accessibility, GIS can help create a more efficient and sustainable waste management system tailored to the needs of the local community (Adeleke *et al*., 2020).

The objective of this research is to provide actionable recommendations for improving SWM in Khalishpur, which may also be applicable to other urban areas facing similar challenges in Bangladesh and beyond. The integration of GIS into urban waste management offers the potential to reduce pollution, improve sanitation, and foster sustainable urban development (Bhuiyan & Hossain, 2017).

Materials and Methods

The methodology is designed to systematically analyze the adequacy of existing waste disposal infrastructure and provide data-driven recommendations for improvement. The approach integrates spatial analysis techniques, field surveys, and stakeholder feedback to ensure the proposed solutions are both practical and sustainable.

Study Area

Site selection: Khalishpur is a metropolitan thana, it is located 4km far from zero point of KCC. It has 35343 households and total area 12.35 km2. In the 1991 Bangladesh census, Khalishpur had a population of 173255. Males constituted 55.95% of the population, and females 44.05%. Population over the age of 18 was 96193. Khalishpur had an average literacy rate of 59.8% (7+ years), above the national average of 32.4%. In the 2011 census, the population was 165,299 (Wikipedia, 2024)

Table 1 Study area (Banglapedia, 2024)

Word No	Total Area	People
g09	2.89 sq km	34614
10	0.95 sq km	18518
11	.36 sq km	19298

Table 1 is about the amount of people and the total area of the study area that are collected from the (Banglapedia, 2024)

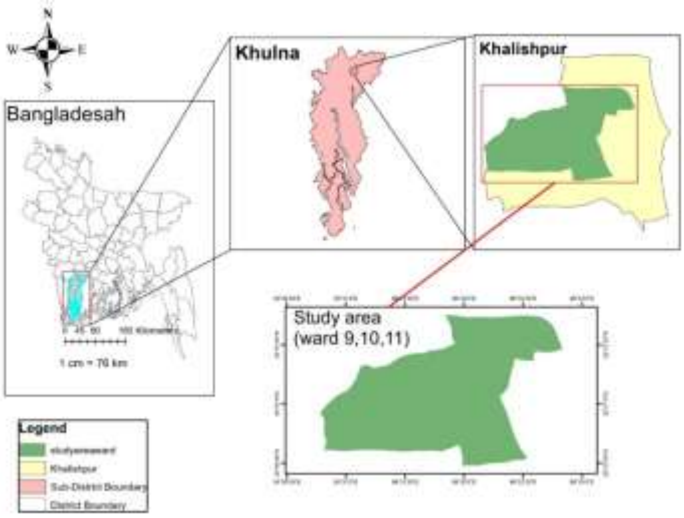

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Figure 1 Map of the Study area.

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DATA COLLECTION

In total, 70 different people from Wards 9, 10, and 11 participated in the survey questions. Their responses provided a comprehensive understanding of local waste management practices, community satisfaction with the current system, and existing barriers to effective waste disposal.

Table 2 : No of participants in the study area.

Survey area	No of male participants	No of female participant
Ward 09	18	12
Ward 10	12	8
Ward 11	12	8

In Table 2 the number of participations is shown.

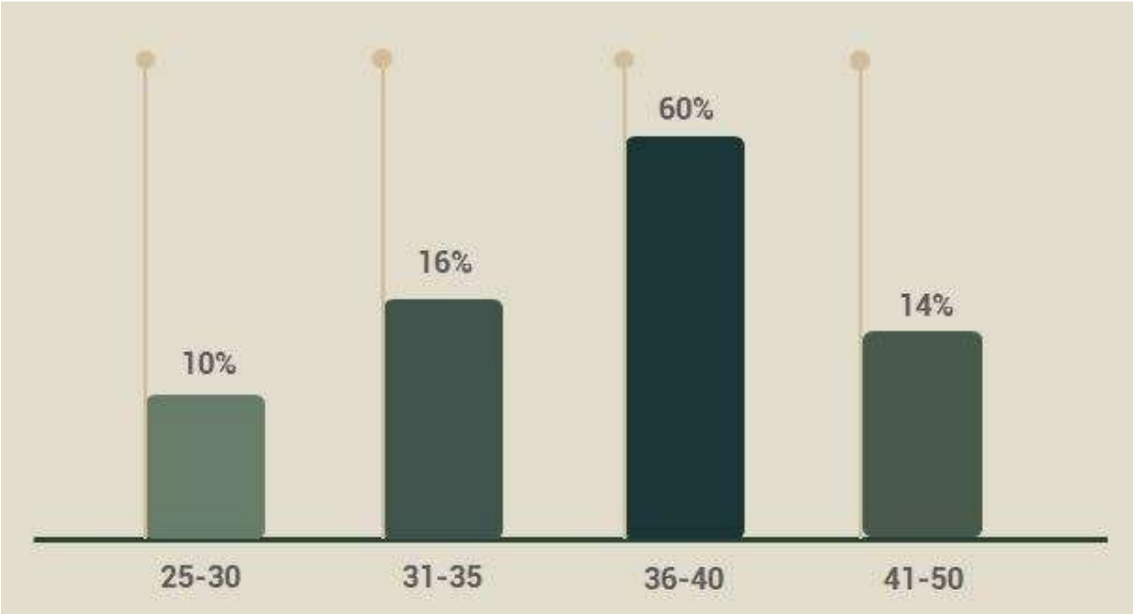

Figure 2 Age group of the participants

The age group of the participants are shown where most of the participants are in 36- 40 age group and the lowest number of 23-30 age group people are participated in the survey.

Table 3 3: Types & amount of waste generation

Area	Food waste	Plastic waste	Paper waste	Other
W-09	5.97 ton/day	1.99 ton/day	1.49 ton/day	0.48 tons/day
W-10	2.99 ton/day	0.99 ton/day	0.75 ton/day	0.25 ton/day
W-11	3.14 ton/day	1.05 ton/day	0.79 ton/day	0.26 ton/day

The Table 3 is about the waste generation rate of my study area which is collected from the questionary survey data.

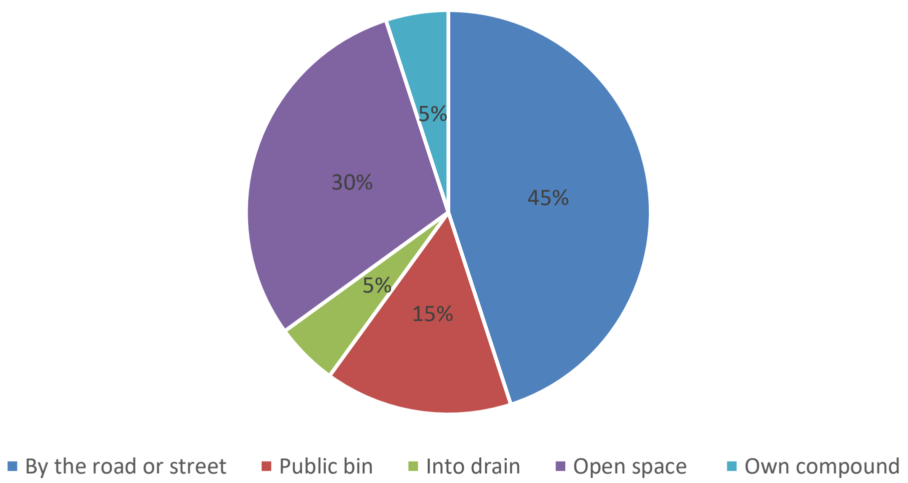

Figure 3 Waste thronging process by the people of the study area.

The figure shows that, the people of the study area, mostly through their waste by the road or street side area and in open space.

Table 4 Health problem estimate in my study area

Area	Skin Infection	Vector-bone diseases (Malaria, Dengue-Fever, Chikungunya)	Gastrointestinal Diseases (Diarrhea, Cholera, Hepatitis A)
Ward 09	07	09	04
Ward 10	03	05	07
Ward 11	01	05	06

The number people infected 47. 10, 5 & 8 people are not infected by the mismanagement of solid waste disposal system. And the survey is done within 70 people over the ward 9, 10 & 11 in Khalishpur, Khulna.

Table 5 People who are aware of the health and environmental problem

Area	Knowledge about health problem (yes-no)		Knowledge about environment problem (yes-no)	
Ward 09	10	20	07	23
Ward10	07	13	05	15
Ward 11	07	13	05	15

The amount of people who are unaware of the problems from the illegal dumping sits is more than the amount of aware people. They actually don't know about the health problem or the environmental problem are generated from the illegal dustbin sits.

DATA ANALYSIS

Waste Generation Analysis
Waste generation data was obtained for each ward:
Ward 9: 9.35 tons/capita/day
Ward 10: 4.99 tons/capita/day
Ward 11: 5.24 tons/capita/day

However, only 75% of this generated waste is assumed to be collected using the dustbin system (with 25% collected via a door-to-door system).
Therefore, the effective waste that needs to be managed through dustbins is calculated as:
Ward 9:
9.35×0.75=7.01tons/day
7.01tons/day=7,010 litters/day
Ward 10:
4.99×0.75=3.74tons/day
3.74 tons/day=3,740 litters/day
Ward 11:
5.24×0.75=3.93tons/day
3.93tons/day=3,930 litters/day
Using a 770-liter dustbin capacity, the total number of dustbins required for each ward is:
Ward 9:
7,010÷770≈10 bins
Ward 10:
3,740÷770≈5bins
Ward 11:
3,930÷770≈5bins
Thus, a total of 20 bins are required for optimal waste management in these three wards.

RESULT & DISCUSSION

A. Current Dustbin Points

Location Distribution: There are 8 dustbin point existed. Which are 5 small container and 3 large containers.
Accessibility: The 35% of the people used the existing dustbins. And 65% people are through their dustbins in open and roads side illegal dustbin points.

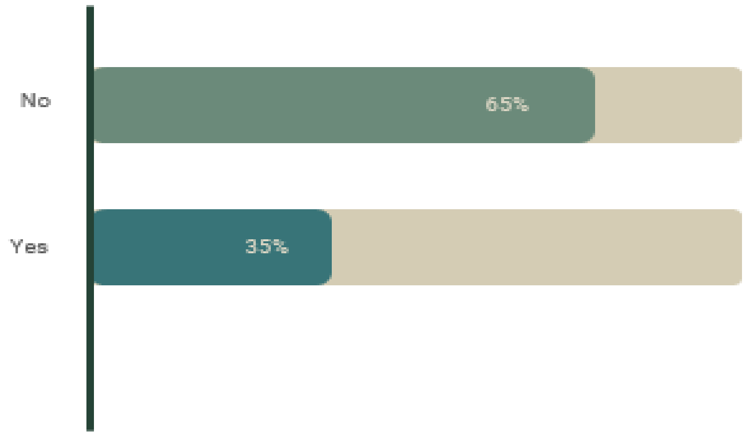

Figure 4 Accessibility of Dustbins

Ward 9 (9.35 tons/capita/day): Given that this ward has the highest waste generation rate, it will naturally require more dustbins or bins with larger capacities to handle the higher waste volume. GIS mapping will help identify high-density residential areas, markets, and busy roads that will need more frequent waste collection or larger bin sizes.
Ward 10 (4.99 tons/capita/day) and Ward 11 (5.24 tons/capita/day): These wards generate less waste than Ward 9, but they still require sufficient dustbin coverage. Here, you can assess if the existing number of dustbins is sufficient to handle the local waste generation. Your GIS analysis can highlight areas where dustbins may be under-utilized, or areas where additional dustbins might be necessary due to population density or the concentration of commercial activity.
A total of 20 bins are required for optimal waste management in these three wards

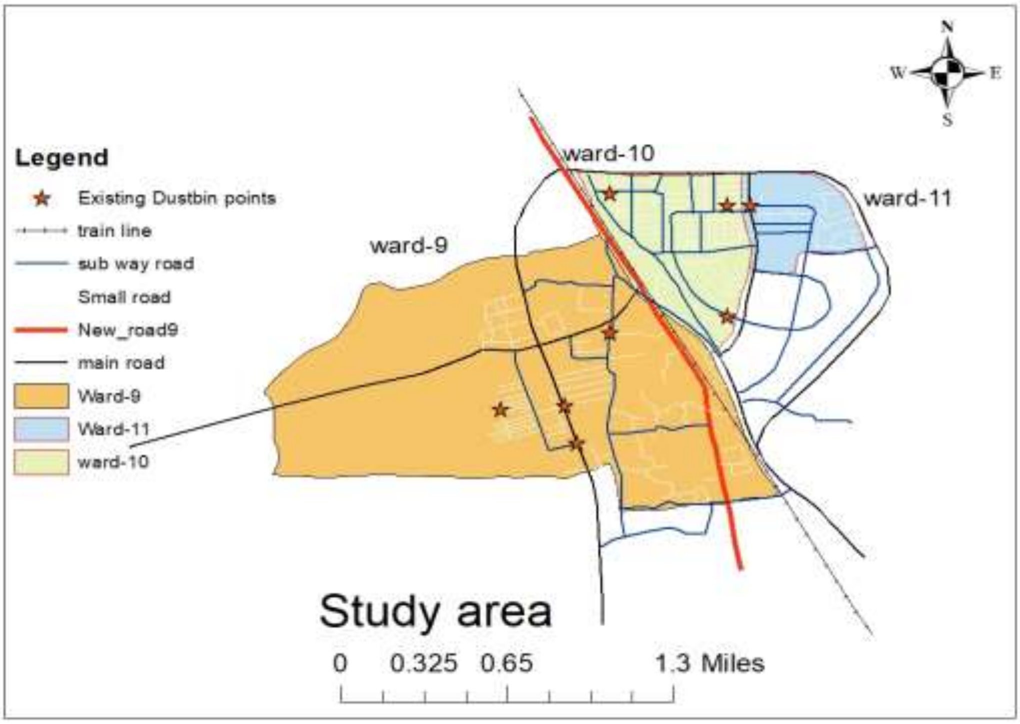

Figure 5 Existing Dustbin points

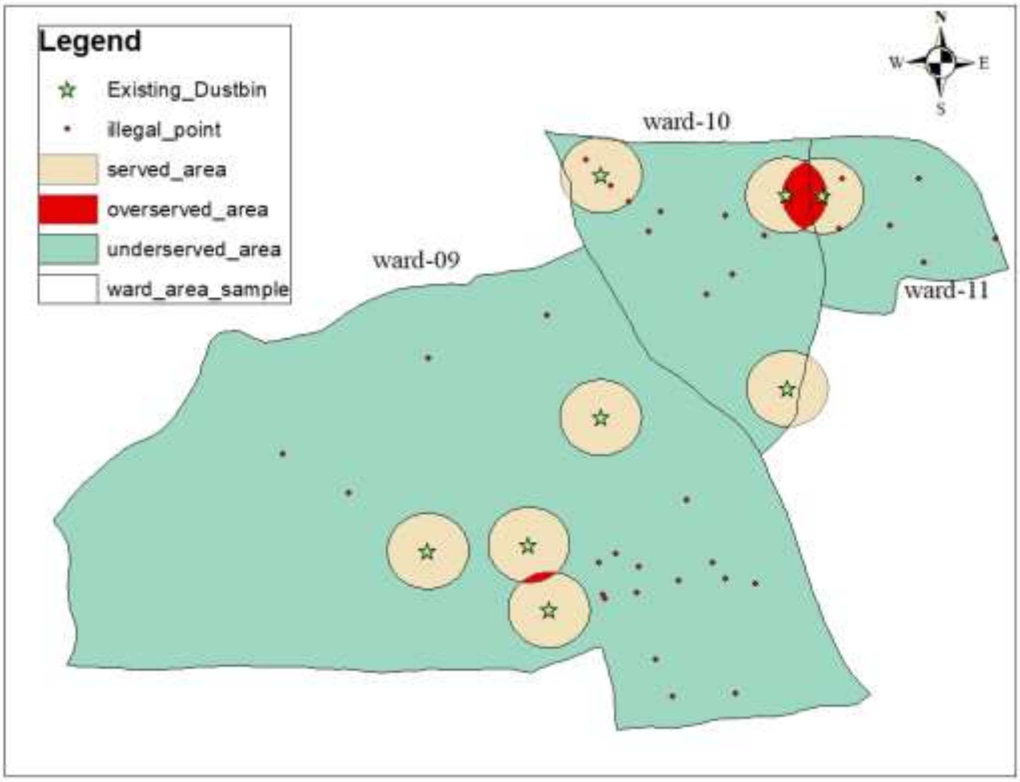

Figure 6 Served, Over-served and Under-served Area (0.15 km area covered).

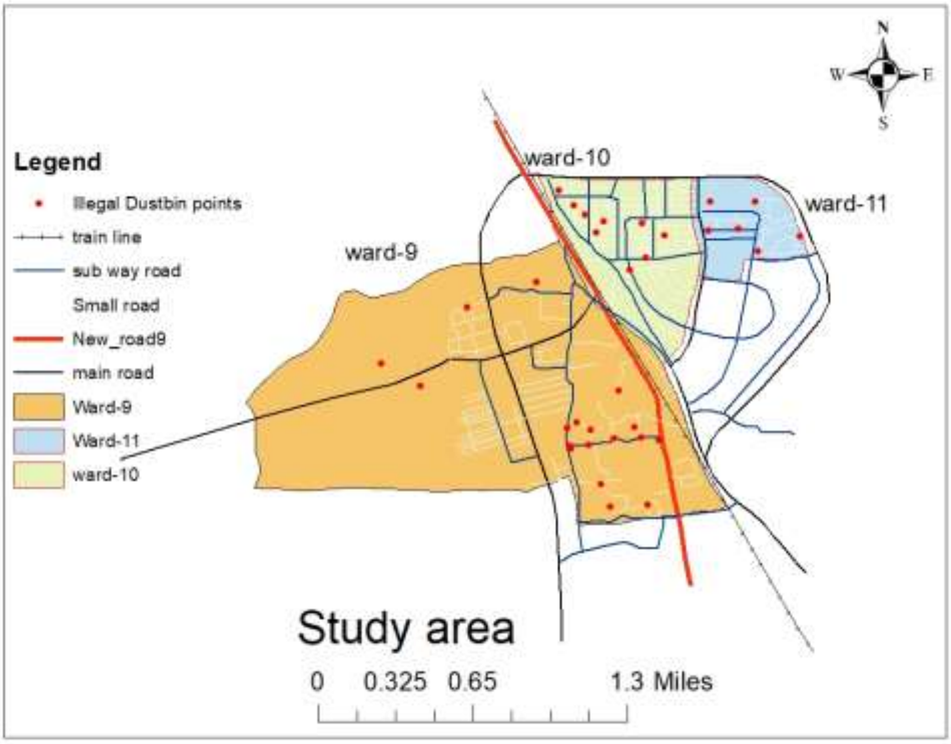

Figure 7 Illegal Dustbin points

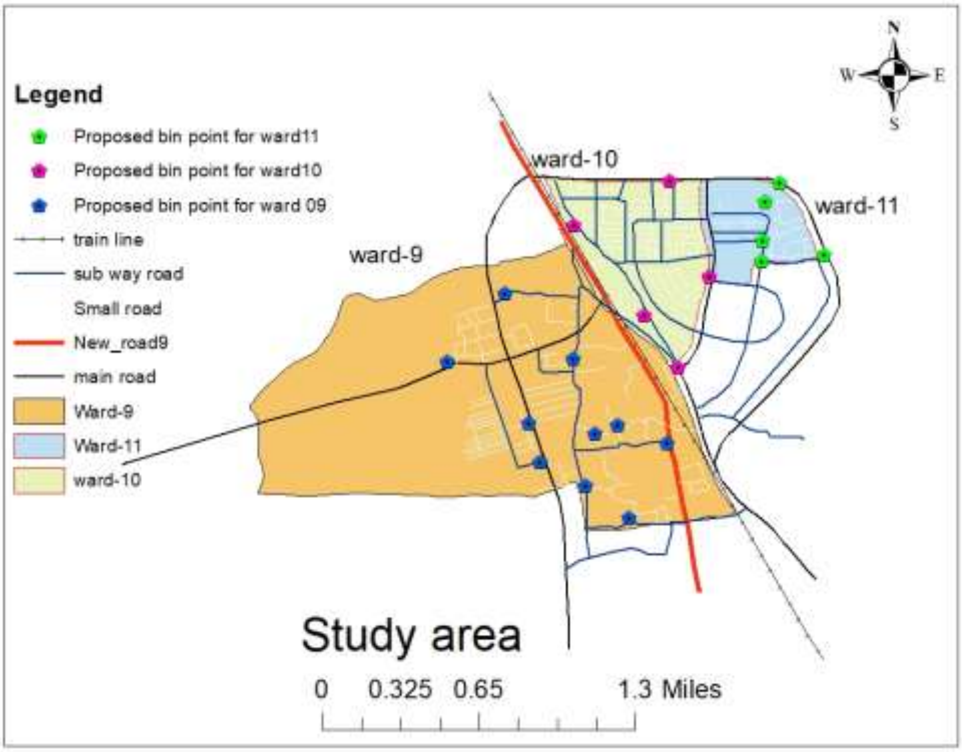

Figure 8 Proposed dustbin points

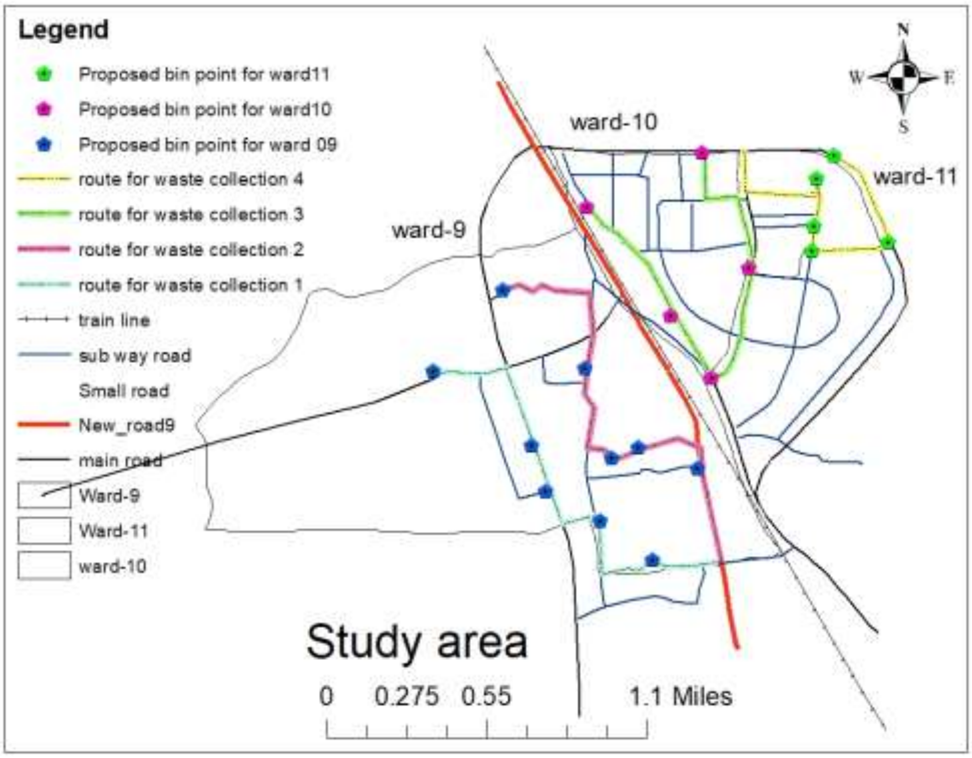

Figure 9 Route map for the recommended dustbin point

From Figure 4, it is clear that, the current dustbin points or existing dustbins accessibility is, Majority Respond "No" (65%):

The majority of respondents (65%) indicate that dustbins are not accessible in their area. This suggests a widespread issue with the placement, availability, or distribution of dustbins in the study area. It reflects a potential gap in waste management infrastructure, which could lead to increased littering, environmental concerns, and hygiene issues.

The Figure 5, shows that the total existing dustbin points in the study area is 8. In ward 9 there is 4 and another 4 is in ward 10 and ward 11.

In Figure 6, the map provides a detailed representation of dustbin accessibility in the study area, derived from field surveys and questionnaire responses. It highlights the locations of existing dustbins, areas served within a 0.15 km radius, underserved regions, overserved areas with overlapping dustbin coverage, and illegal dumping points. The area is divided into three wards: Ward 09, Ward 10, and Ward 11, offering a clear spatial understanding of dustbin distribution.

One of the key observations from the map is the uneven coverage of dustbins. Wards 09 and 11 are predominantly underserved, as indicated by the large green areas where no dustbins are accessible within the defined radius. This aligns with the survey results, where a significant majority of respondents indicated that dustbins are not accessible. On the other hand, Ward 10 shows better coverage, but it also has areas of redundancy, where the served areas of multiple dustbins overlap. This overlap suggests that resources are not being used efficiently and could be redistributed to improve overall accessibility.

The chosen radius of 0.15 km provides a practical basis for analysing accessibility. However, it may be useful to consider whether residents within this range actively use the available dustbins. Behavioural factors, such as convenience, awareness, and waste disposal habits, should also be taken into account when planning improvements.

To address these challenges, it is essential to consider redistributing dustbins from overserved areas in Ward 10 to underserved areas in Wards 09 and 11. This would help reduce illegal dumping points and create a more equitable waste management system. Additionally, community awareness campaigns could encourage residents to use dustbins effectively, while regular monitoring and updates to the map would ensure that any changes to the system remain effective over time. By implementing these measures, the study area could benefit from a cleaner environment, reduced health risks, and greater community satisfaction. This analysis provides a strong foundation for targeted interventions to improve waste management in the area.

In Figure 7, the map illustrates the study area's road network, ward boundaries, and the distribution of 34 illegal dumping points. The wards—Ward 9, Ward 10, and Ward 11—show varying levels of road density, which impacts waste disposal accessibility. Ward 9, with sparse small roads, and Ward 11, despite being smaller, exhibit significant illegal dumping activity due to inadequate waste management facilities. Ward 10, though better connected with main and subway roads, also faces dumping issues, particularly along major routes.

The presence of 34 illegal dumping points highlights the urgent need for strategic placement of dustbins along key roads and increased waste collection services. Proximity to transportation lines further raises environmental and public health concerns, emphasizing the need for immediate action.

And by the map in Figure 8, the proposed dustbin points are denoted, the elation of the area is based on the un-served area and the un accessible dustbins areas. Also, the location data such as longitude and attitude are collected by GPS system.

The map in Figure 9, are proposed waste collection routs from the proposed dustbin points. From ward 9 there is two rout, rout 1 & rout 2. Couse the dustbins are 10, and for Ward 10 and ward 11 the rout 3 & rout 4 is proposed.

CONCLUSION

This study provides critical insights into the current solid waste disposal management system, highlighting inefficiencies in dustbin placement, accessibility, and collection logistics. Using GIS technology, it identifies optimal locations for dustbins based on population density, waste generation rates, accessibility, and environmental considerations. The findings support informed decisions such as redistributing resources, optimizing collection routes, and improving accessibility, contributing to a more efficient and sustainable waste management system. By addressing immediate challenges and offering scalable GIS-based solutions, this research promotes a cleaner, healthier environment and establishes a replicable framework for urban waste management.

RECOMMENDATIONS

This paper recommend that the large use of GIS analysis can be applied for the study but for the limitations of time and money the software is used in this paper is unapplied. The study area can be applied larger than this paper. The amount of solid waste generation is calculated in this but types and separation can also be part of this study.

REFERENCES

Adeleke, S. A., Olayemi, J. A., & Akinlabi, E. T. (2020). Solid waste management and environmental sustainability: A case study of urban centers in developing countries. *Journal of Environmental Management, 256*, 109876. https://doi.org/10.1016/j.jenvman.2019.109876

Bhuiyan, M. A. H., & Hossain, M. I. (2017). Public health risks of improper solid waste management in urban areas of Bangladesh. *Environmental Health Perspectives, 125*(6), 650–658. https://doi.org/10.1289/EHP2121

Hossain, M. T., & Jahan, S. (2020). The impact of solid waste on public health and the environment in developing countries: A review of Bangladesh. *International Journal of Environmental Science and Technology, 17*(4), 1633-1644. https://doi.org/10.1007/s13762-020-02740-z

Khan, M. A., Rahman, M. M., & Sattar, M. A. (2019). Solid waste management in developing countries: Challenges and opportunities in Bangladesh. *Waste Management, 94*, 347-355. https://doi.org/10.1016/j.wasman.2019.06.019

Liu, C., & Zhao, X. (2015). The role of GIS in optimizing urban solid waste management. *Urban Studies, 52*(9), 1632-1647. https://doi.org/10.1177/0042098014557640

Rahman, M. M., & Sattar, M. A. (2019). Sustainable solid waste management in urban Bangladesh: Exploring opportunities and challenges. *Environmental Progress & Sustainable Energy, 38*(6), 1989-1996. https://doi.org/10.1002/ep.13195